Fluoride Treatment of Hydroxyapatite – Mechanisms and Effects

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Tooth enamel consists by more than 95 % of hydroxyapatite (HAP). Since decades, fluoride treatment of teeth is used due to its caries-prophylactic effect, e.g., in fluoride containing toothpastes or mouthwashes. However, the exact mechanisms of the fluoride uptake are yet to be explored.
We used sintered hydroxyapatite pellets as a model system for a tooth surface and treated it with a NaF-solution. XPS-measurements in combination with Ar-ion-etching revealed that the thickness of the fluoridated layer which forms on the HAP surface is in the range of only a few nanometers [1]. By using different application times of the NaF-solution, we found that both the thickness of the fluoridated layer and the overall amount of fluoride taken up reach a state of saturation on a timescale of about 3 min [1].
Etching experiments with pure and fluoridated HAP surfaces showed a very strong effect of the fluoridation. Although the fluoridated layer is extremely thin and contains only minute amounts of fluoride, AFM-measurements showed a complete inhibition of etching on the fluoridated surface for at least 5 min. The major part of the surface withstood etching even for more than 23 min [2].
These findings give new insight into the mechanisms and especially the timescale of fluoride uptake by HAP and show how the incorporated fluoride in HAP correlates with its protective impact.

[1] T. Faidt, C. Zeitz, S. Grandthyll, M. Hans, M. Hannig, K. Jacobs, and F. Müller, ACS Biomater. Sci. Eng. **3** (2017) 1822–1826.

[2] T. Faidt, A. Friedrichs, S. Grandthyll, C. Spengler, K. Jacobs, and F. Müller, Langmuir **34** (2018) 15253–15258.